



Sloan Digital Sky Survey (SDSS-II) Status

Huan Lin

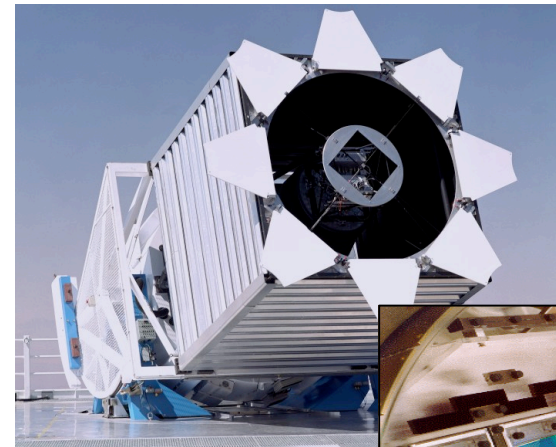


Sloan Digital Sky Survey-II (E949) 2005-2008 (underway)



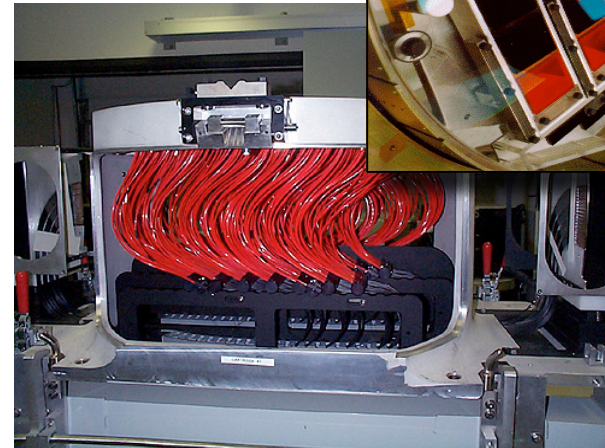
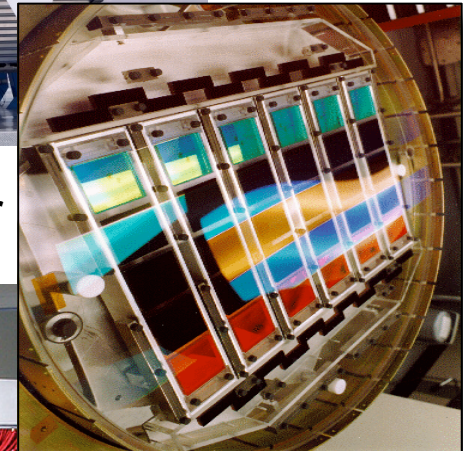
Collaboration: ~150 scientists from

Am. Museum Nat. History
Astrophysical Inst. Potsdam
U. Basel
Cambridge U.
Case Western Reserve
U. Chicago
Drexel U.
Fermilab
Institute for Adv. Studies
Japanese Participation Grp
Johns Hopkins U.
JINA
Kavli Institute for Part. Astro.
Korean Scientist Group
LAMOST (China)
Los Alamos Nat. Lab
Max Planck Inst. Astron.
Max Planck Inst. Astrophys.
New Mexico State U.
Ohio State U.
U. Pittsburgh
U. Portsmouth
Princeton U.
US Naval Obs.
U. Washington



Beamline

Calorimeter



Massive Spectrometer

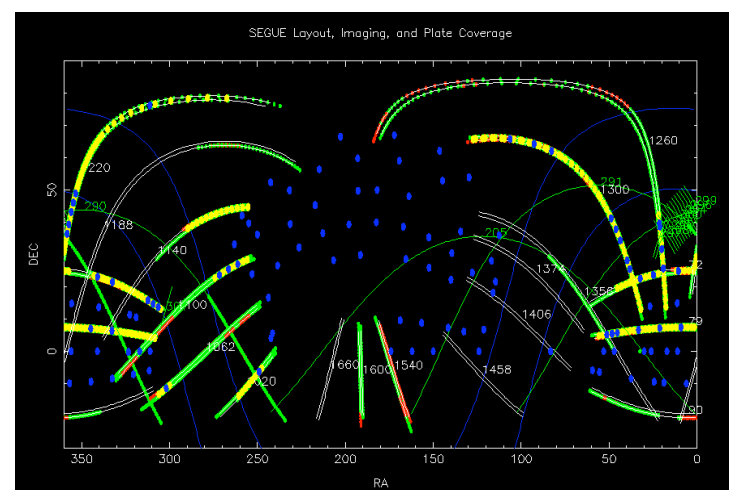
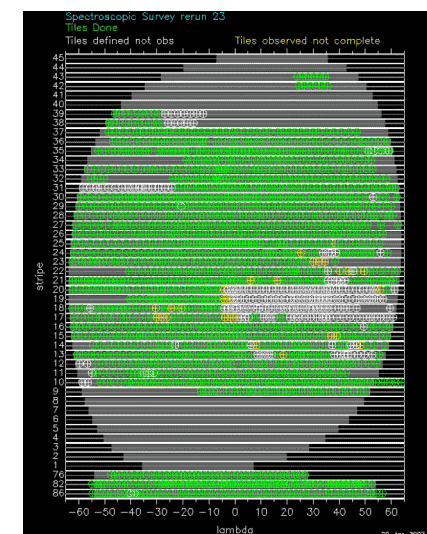
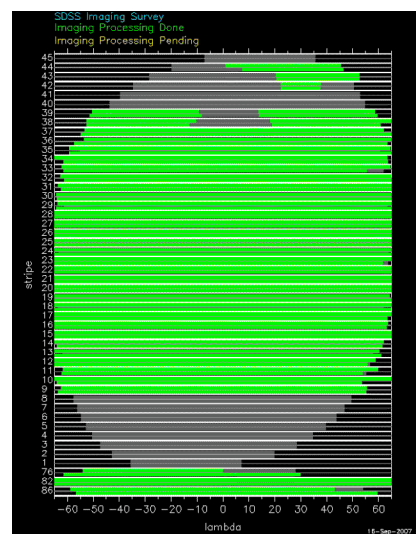


SDSS-II: The sequel

Its 3 year mission (2005-2008)



- **Legacy:**
 - Imaging and Redshift survey - Large scale structure
- **SEGUE:**
 - Milky Way halo – mergers – Dark Matter probe
- **Supernovae**
 - Low and intermediate redshift – Dark Energy probe
- **Funding:**
 - NSF, Sloan, DOE, NASA, Max Planck Society, Higher Ed. Fund. Council, UK, Japanese Mongbukagakusho





FNAL science interests, tasks, and resources in SDSS-II



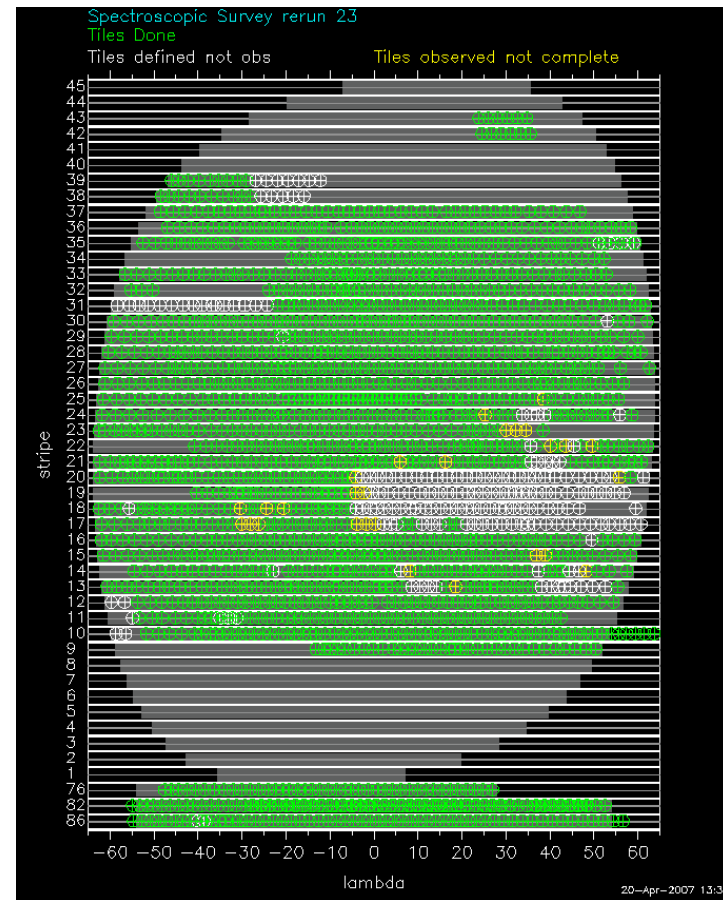
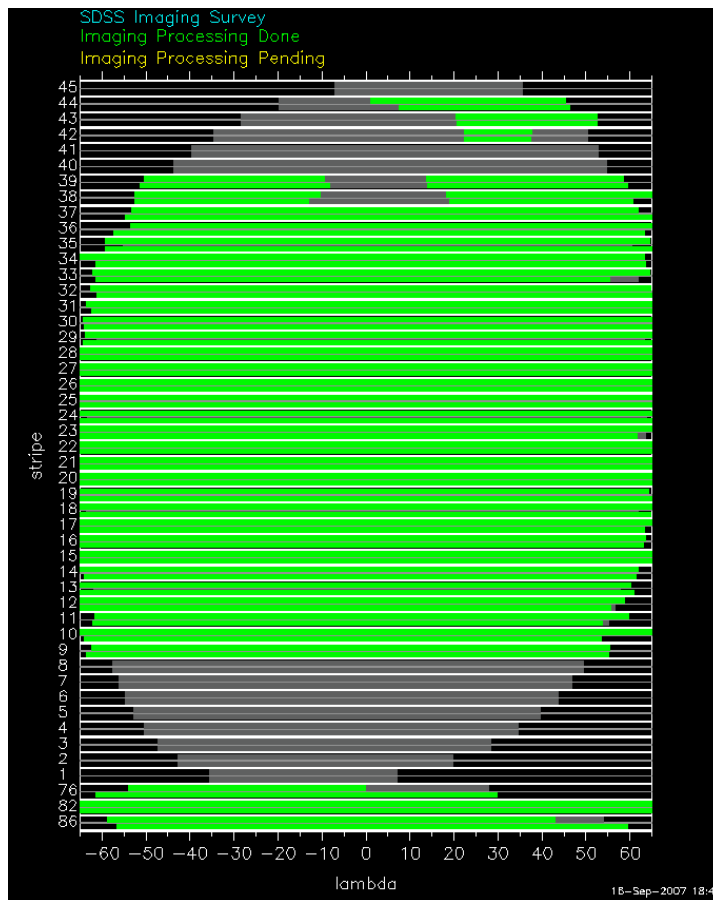
- **Fermilab Science Interests**
 - 13 scientists
 - 3 current postdocs
 - Leadership roles in SEGUE and Supernova survey
 - Galaxy clusters
 - Strong and weak lensing
 - Stripe 82 coadd
 - Photometric redshifts
- **Tasks**
 - Survey planning
 - Legacy, SEGUE, SNe data processing
 - Data distribution
 - Plug plate design
 - Project mgmt.
 - Project director support
 - APO Engineering/Technical support
- **Required Resources**
 - 4 FTE scientist (mainly from CD)
 - 10 FTE CP, admin, tech.
- **Funding**
 - Significant cost sharing with SDSS project (\$1.2 million)



Status - Legacy



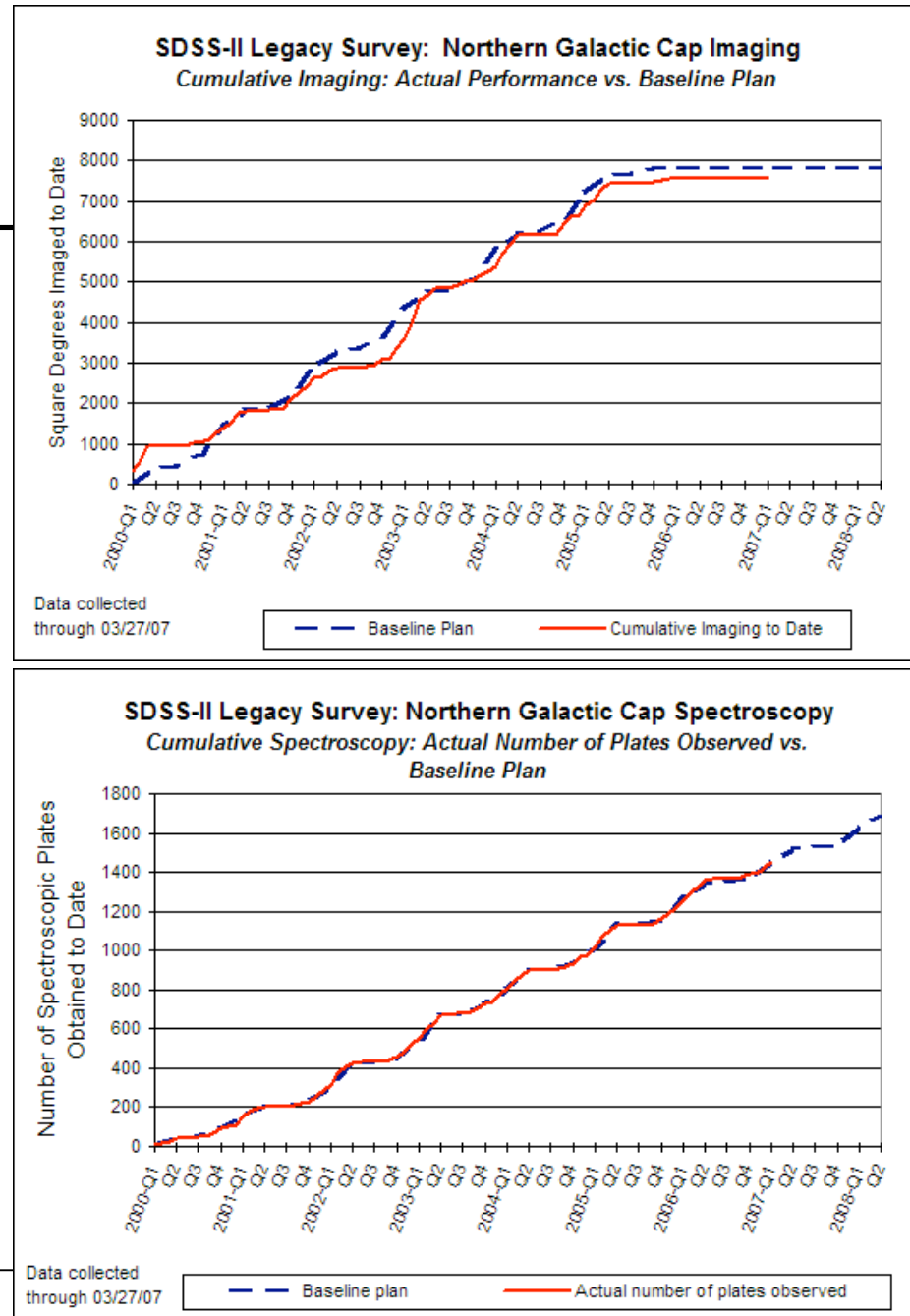
Imaging Footprint (8000 sq deg) Spectro footprint: 1700 plates



Imaging is complete (gap filled)! Spectroscopy on track (one year left).



Legacy Survey: delivered "beam" vs. 8 yr. baseline



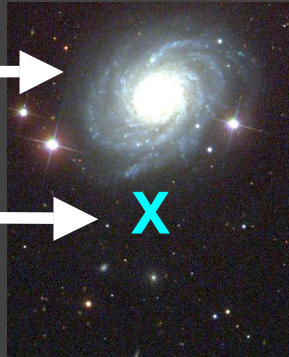


Gravitational Lensing



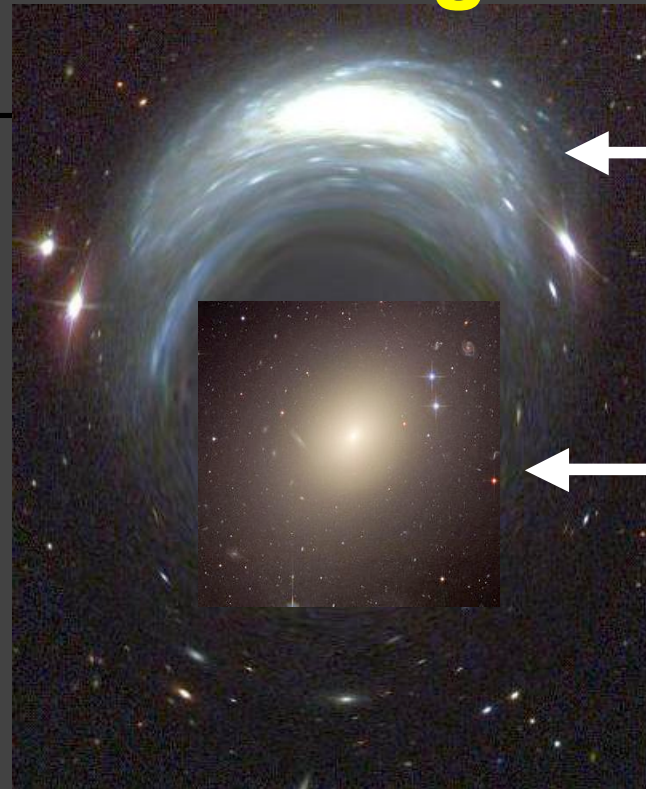
Distant
Galaxy
 $z=2$

No
intervening
galaxy



No lensing

Keck Telescope
(\$100 million)



Distant
Galaxy
 $z=2$

Intervening
galaxy with
dark matter
 $z=0.5$

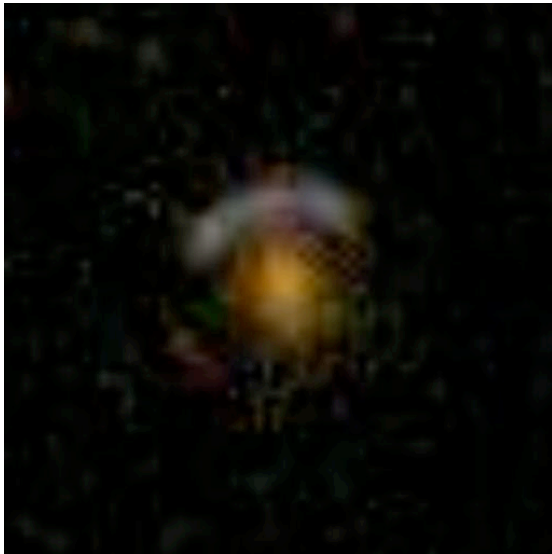
SDSS 2.5m telescope
+ Dark Matter Lens
(\$15 million)

Benefit of Dark Matter: Net savings \$85 million

***Active research in gravitational lensing using SDSS data, carried out by
Fermilab Center for Particle Astrophysics scientists***



Search for Bright, High-Redshift, Gravitationally Lensed SDSS Galaxies



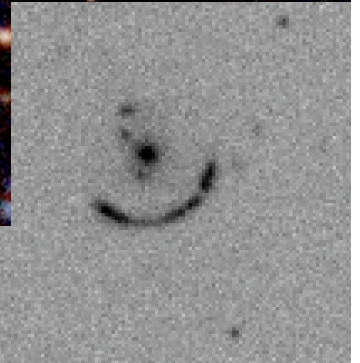
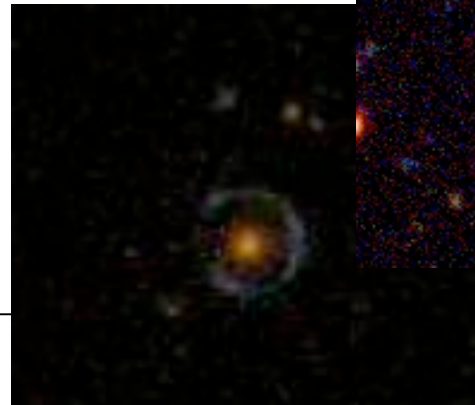
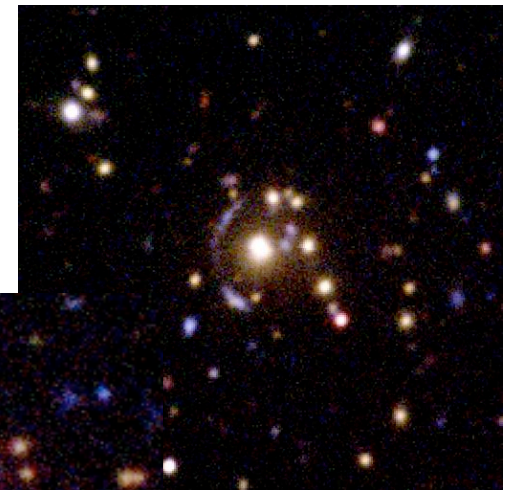
The 8 O'Clock Arc, the brightest known lensed Lyman Break Galaxy (LBG), with a redshift $z=2.73$ (Allam et al. 2007, ApJ, 662, L51)



4 more newly confirmed lensed arc systems from SDSS, with high redshifts $z=2.0-2.4$



Discovered via systematic searches of the SDSS DR5 data by FNAL scientists, with ongoing and proposed multi-wavelength follow-up from ground and space-based telescopes



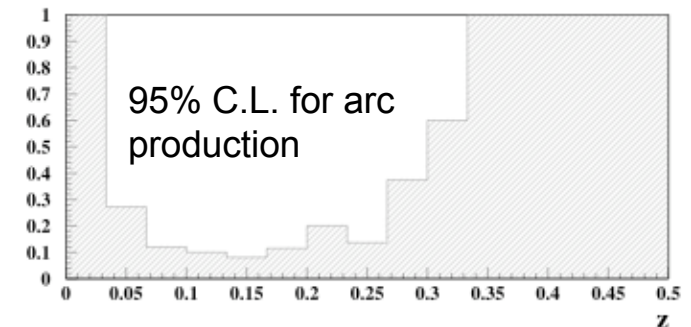
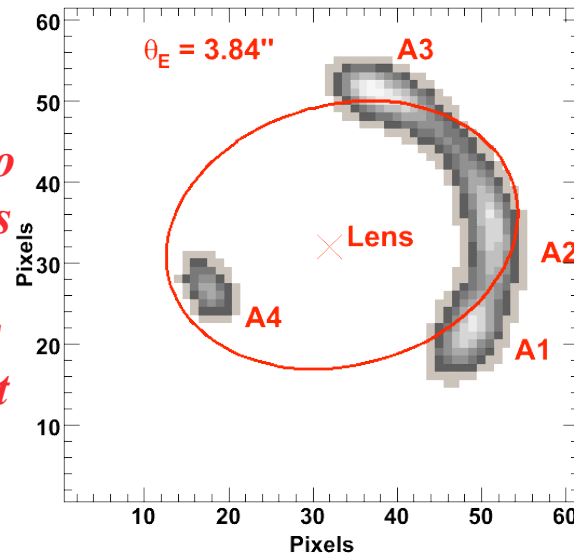
Sep 26, 2007



Strong and Weak Lensing Probes of Dark Matter



*Lens modeling to
constrain masses
of lensing
galaxies/clusters
(Buckley-Geer et
al., in prep.)*



*SDSS arc search set limits on
cluster lensing probability
(Estrada et al. 2007, ApJ, 660,
1176) and affects models of
cluster mass distribution*



*First measurement of Coma
Cluster mass using weak
lensing, enabled by SDSS data
(Kubo et al. 2007, ApJ, in press);
lowest redshift cluster for which
this has been done*

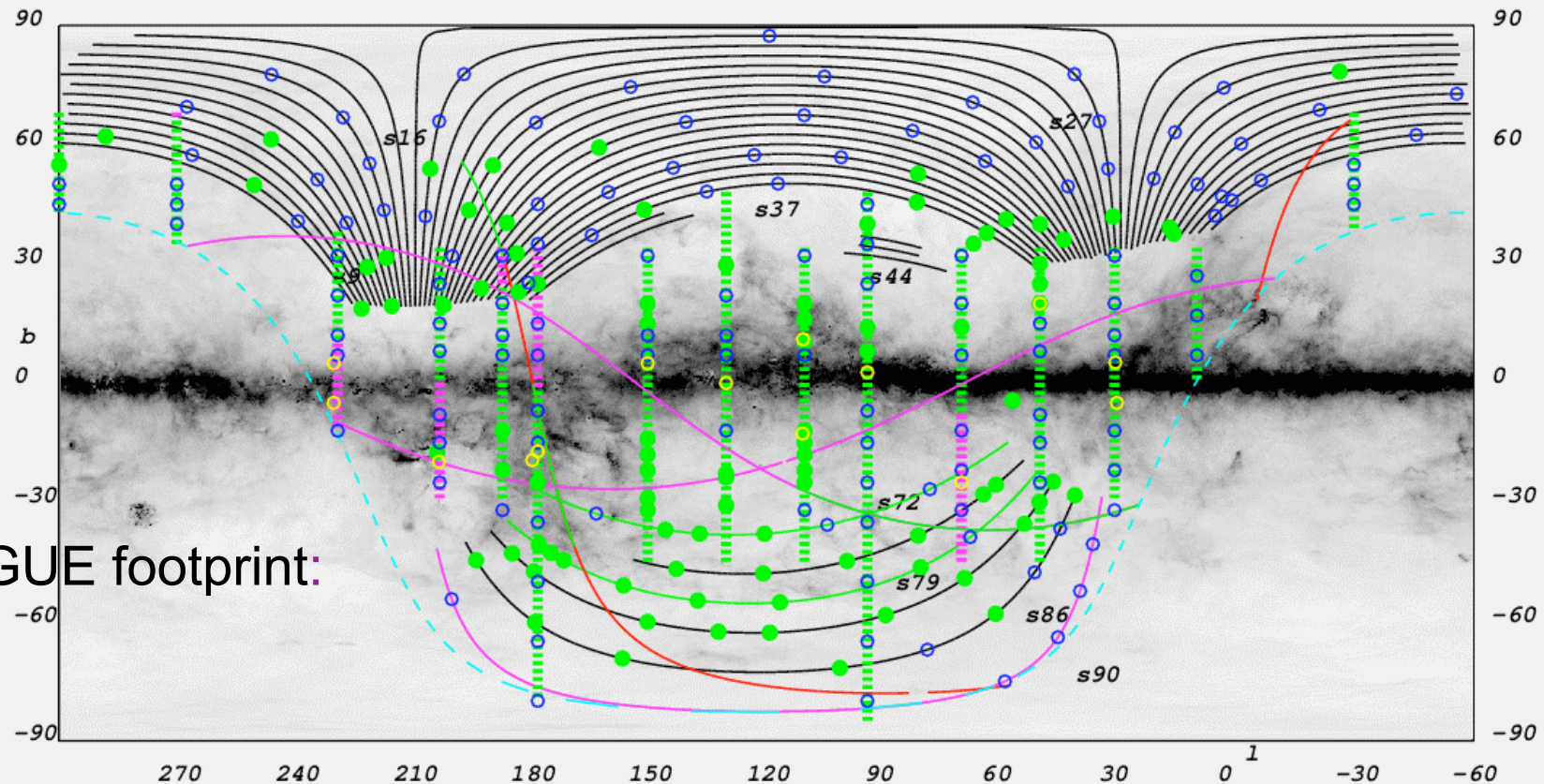


SEGUE

(v.): To proceed to what follows without pause



SEGUE footprint:



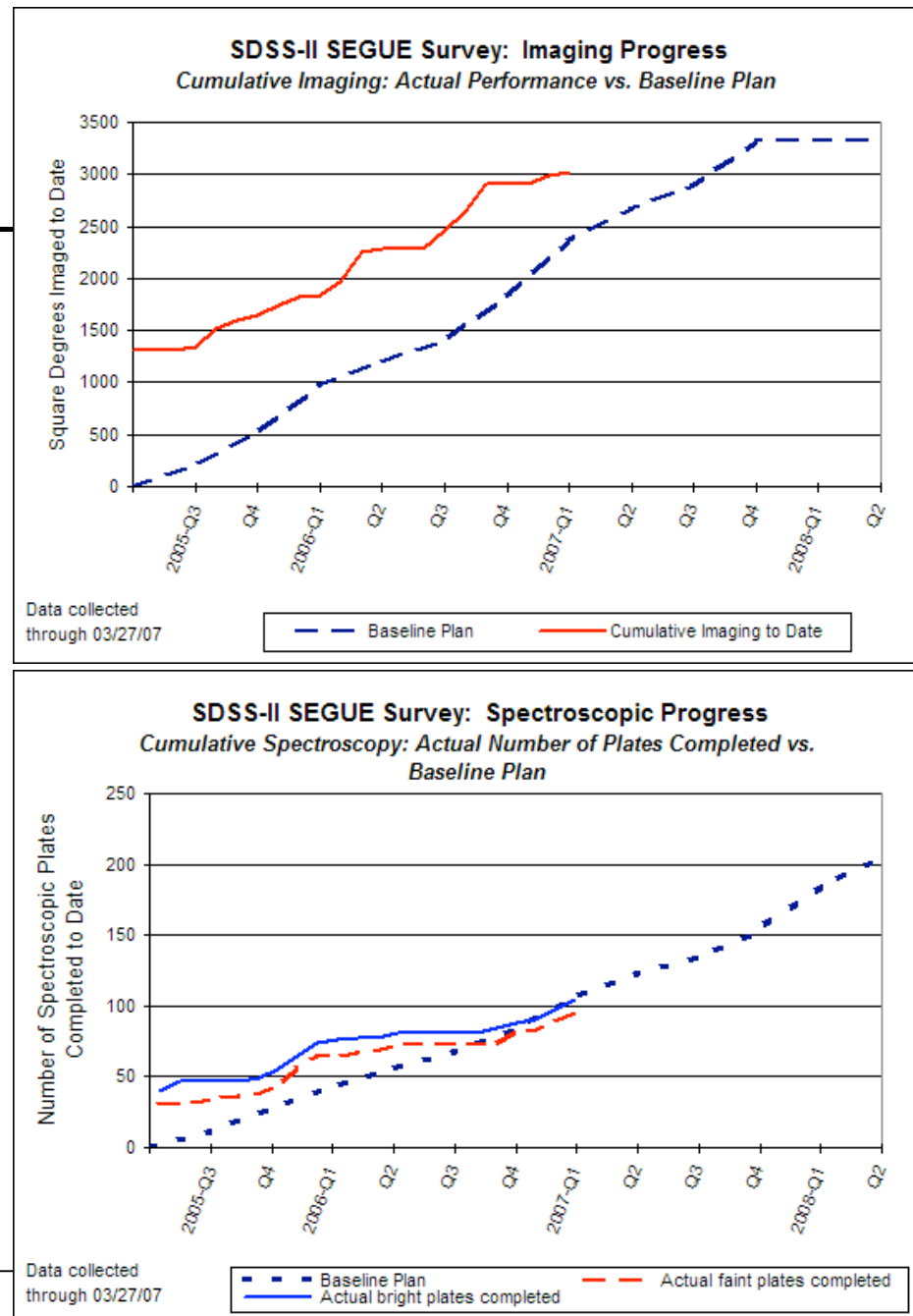
The SEGUE experiment combines accurate low-latitude stellar photometry with radial velocities and chemical abundance information from spectroscopy to answer questions about the global structure of the Milky Way, including its **DARK MATTER** halo.



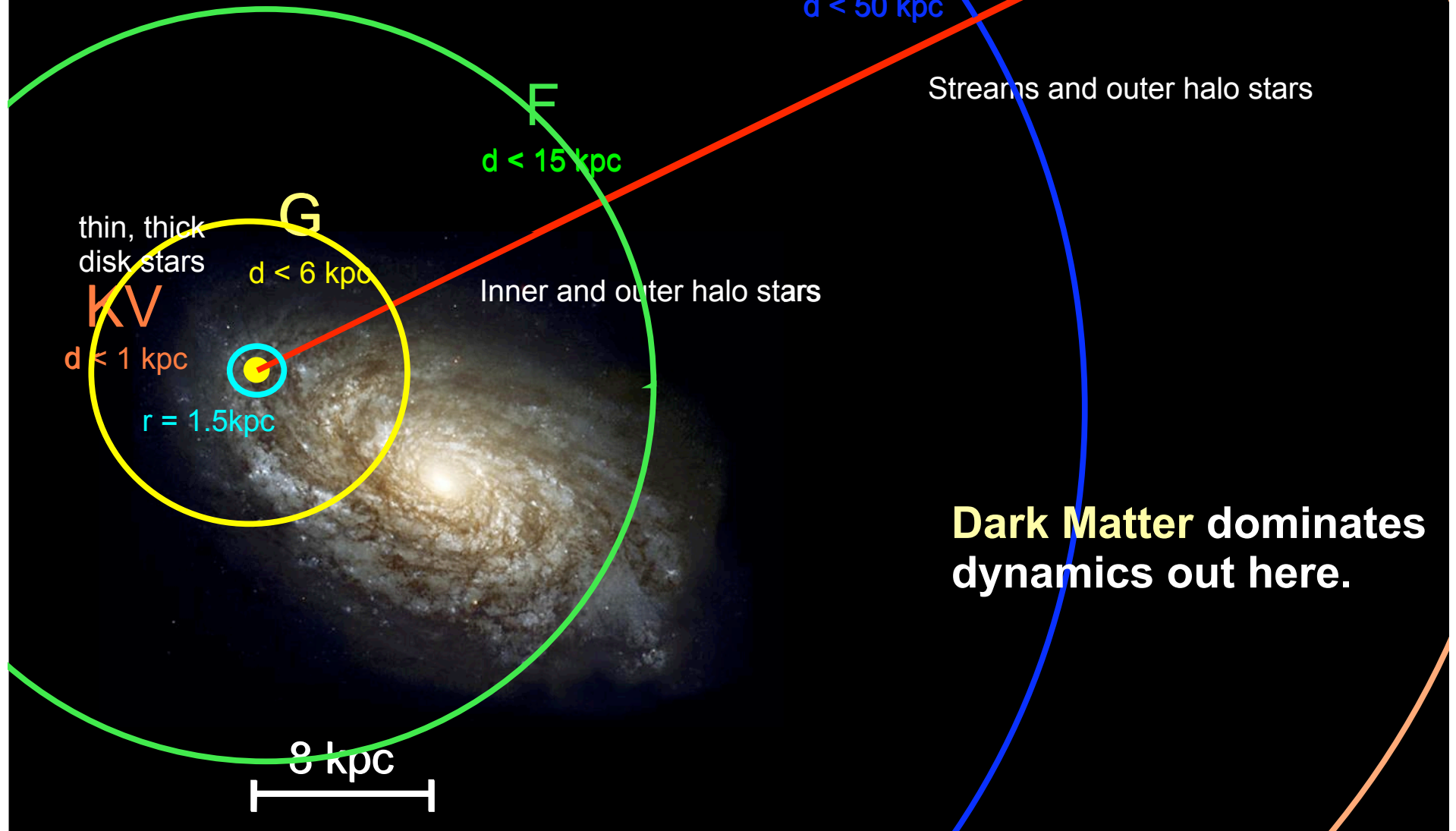
Ahead of
Imaging
baseline:

**Segue Survey:
delivered "beam"
vs. 3yr. baseline**

In-line with
Spectro
baseline:



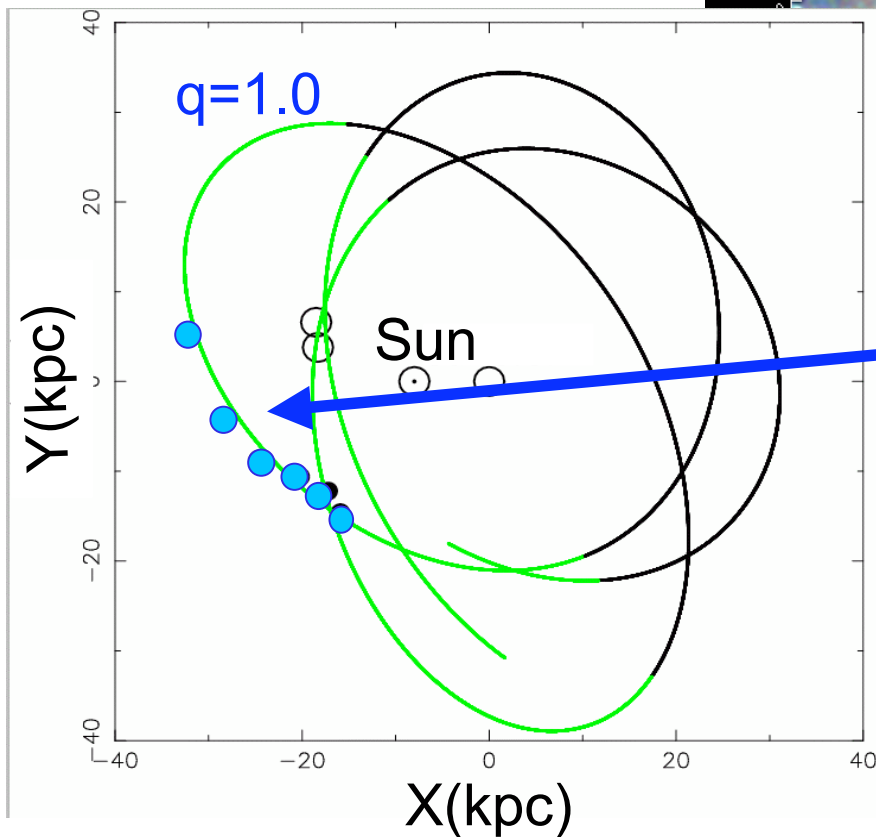
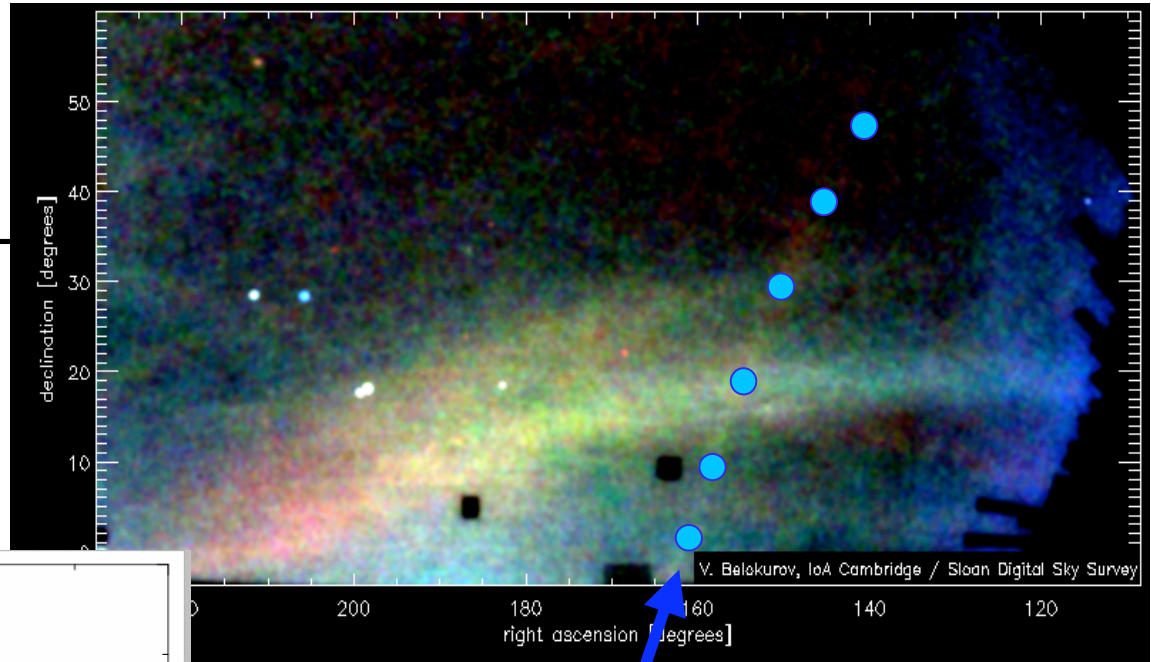
SEGUE uses stellar probes of increasing absolute brightness to probe increasing distances in the disk, thick disk and Milky Way halo.





Star streams as probes of Dark Matter!

Example: Fit with $q=1.0$
model implies
consistency with
Spherical halo.



Fitting the orbit of the
'Orphan stream' in 3-D can constrain
the flattening of the Dark Matter
Halo surrounding our Milky Way
Galaxy.

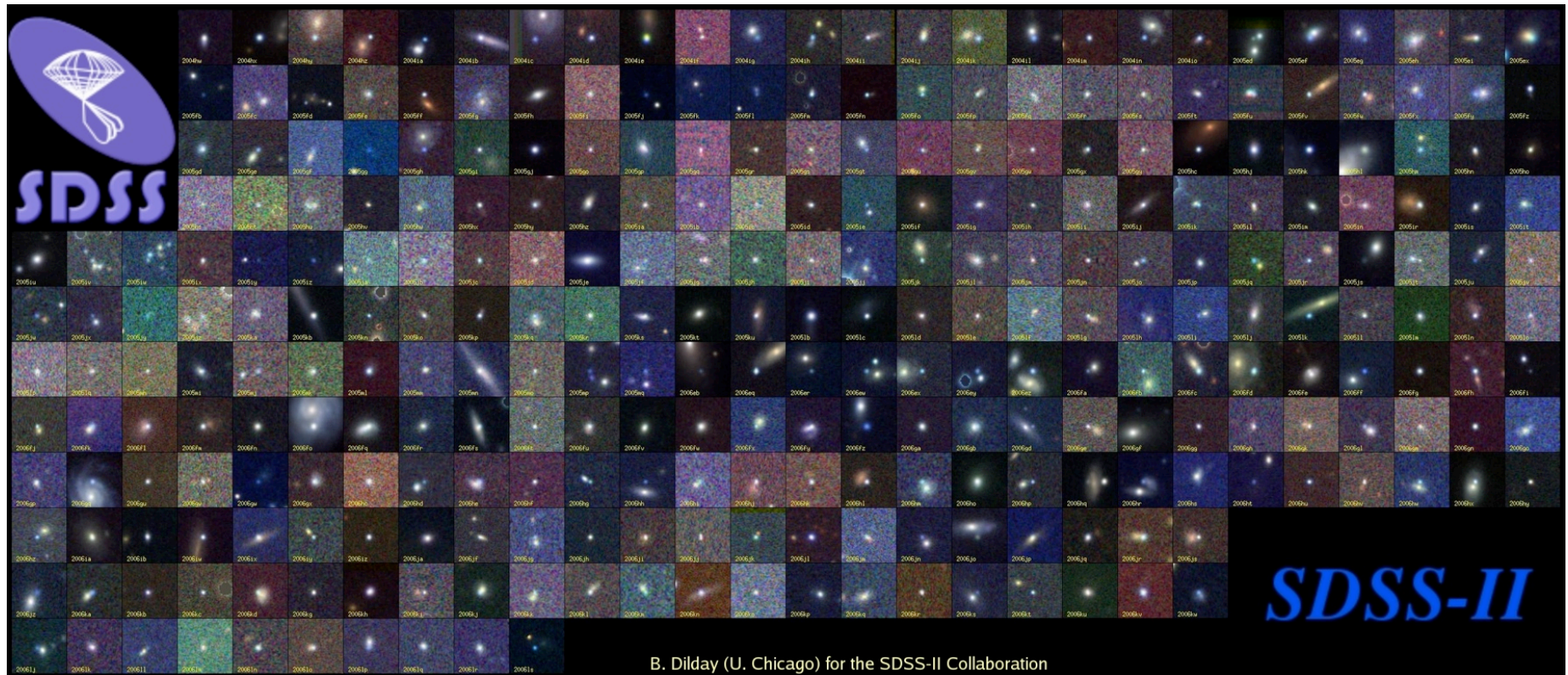
SEGUE Publications

Scientific publications based on SEGUE data or SDSS stellar imaging are listed below. A more general list of SDSS publications can be found at www.sdss.org/publications.

Title	First Author	astro-ph	Journal
The SEGUE Stellar Parameter Pipeline. II. Validation with Galactic Globular and Open Clusters	Y. S. Lee	pdf	AJ submitted
The SEGUE Stellar Parameter Pipeline. I. Description and Initial Validation Tests	Y. S. Lee	pdf	AJ submitted
The Overdensity in Virgo, Sagittarius Debris, and the Asymmetric Spheroid	Heidi Jo Newberg	0706.3391	AJ in press
Estimation of stellar atmospheric parameters from SDSS/SEGUE spectra	P. Re Fiorentin	0703309	A&A accepted
The Hercules-Aquila Cloud	V. Belokurov	0701790	ApJ Lett. in press
SDSS Spectroscopic Survey of Stars	Z. Ivezić	0701509	Mem. Soc. Ast. It. 77, 1057
A Survey of Open Clusters in the u'g'r'i'z' Filter System: III. Results for the Cluster NGC 188	B. Fornal	0611900	AJ 133, 1409
Understanding white dwarf binary evolution with white dwarf/main sequence binaries: first results from SEGUE	M.R. Schreiber	0611461	Proc., 15th Eur. Workshop on WDs
Is Ursa Major II the Progenitor of the Orphan Stream?	M. Fellhauer	0611157	MNRAS 375, 1171
Cats and Dogs, Hair and A Hero: A Quintet of New Milky Way Companions	V. Belokurov	0608448	ApJ 654, 897
A Curious New Milky Way Satellite in Ursa Major	D. B. Zucker	0606633	ApJ Lett 650, L41
An Orphan in the "Field of Streams"	V. Belokurov	0605705	ApJ in press
The Field of Streams: Sagittarius and its Siblings	V. Belokurov	0605025	ApJ Lett 642, L137
A Faint New Milky Way Satellite in Bootes	V. Belokurov	0604355	ApJ Lett 647, L111
A New Milky Way Dwarf Satellite in Canes Venatici	D. B. Zucker	0604354	ApJ Lett 643, L103
A Spectroscopic Study of the Ancient Milky Way: F- and G-Type Stars in the Third Data Release of the Sloan Digital Sky Survey	C. Allende Prieto	0509812	ApJ 636, 804
The Metallicity Distribution Function of the Halo of the Milky Way	Timothy C. Beers	0508423	IAU Symp. 228
The Milky Way's stellar halo - lumpy or triaxial?	Heidi Jo Newberg	0507671	J. of Phys. Conf. Proc.
The Halo of the Milky Way	Heidi Jo Newberg	0502386	ASP Conf. Series
A comprehensive model for the Monoceros tidal stream	J. Penarrubia	0410448	ApJ 626, 128
A New Milky Way Companion: Unusual Globular Cluster or Extreme Dwarf Satellite?	Beth Willman	0410416	AJ
A Survey of Open Clusters in the u'g'r'i'z' Filter System: I. Results for NGC2548 (M48)	C. J. Rider	0312555	AJ 127, 2210



SDSS-II Supernova Survey



- Obtain a few hundred *high-quality* SNe Ia light curves in the “redshift desert” $z \sim 0.05-0.35$, by scanning 280 deg² SDSS Stripe 82 with 2-day cadence over 3 months each Fall
- **Probe Dark Energy** using continuous Hubble diagram, connecting with complementary low- and high-redshift measurements

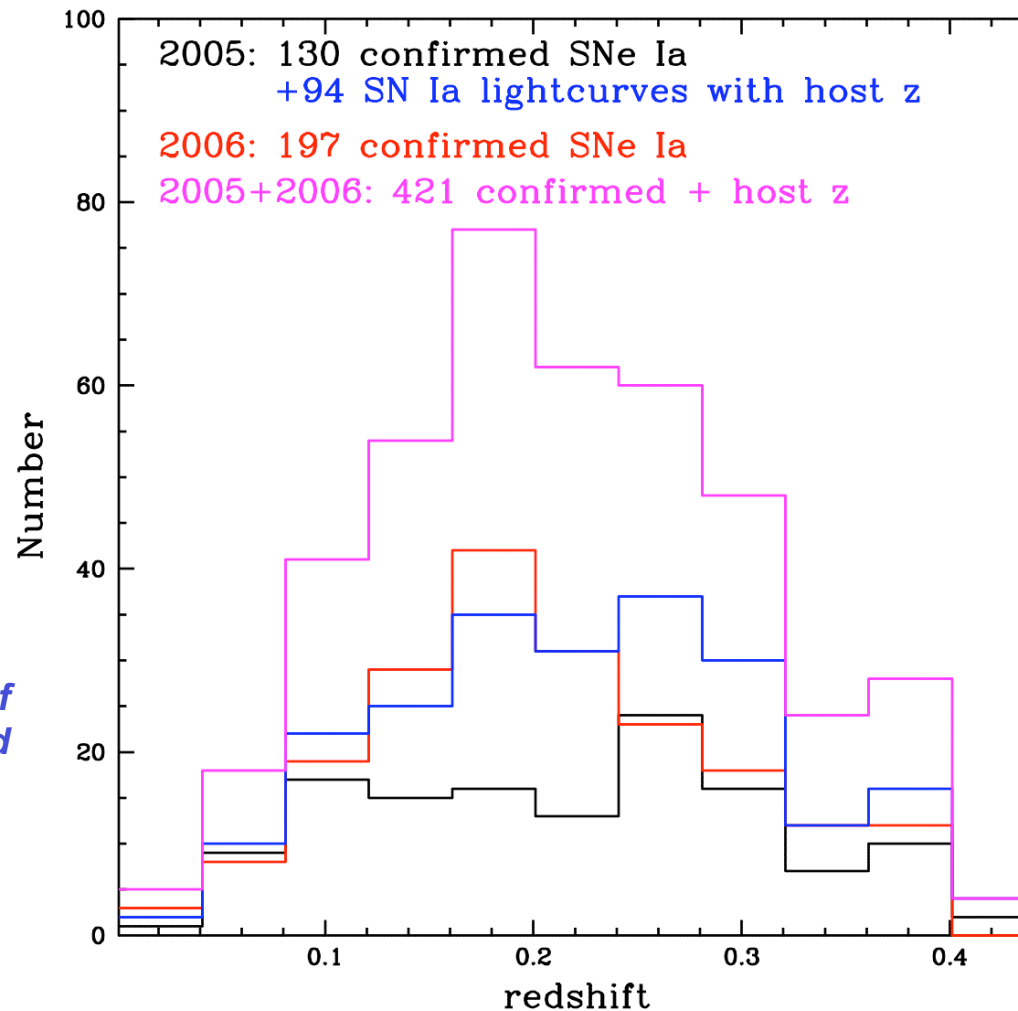


Redshift Distribution for SNe Ia



Largest SN Ia
sample from a
single survey

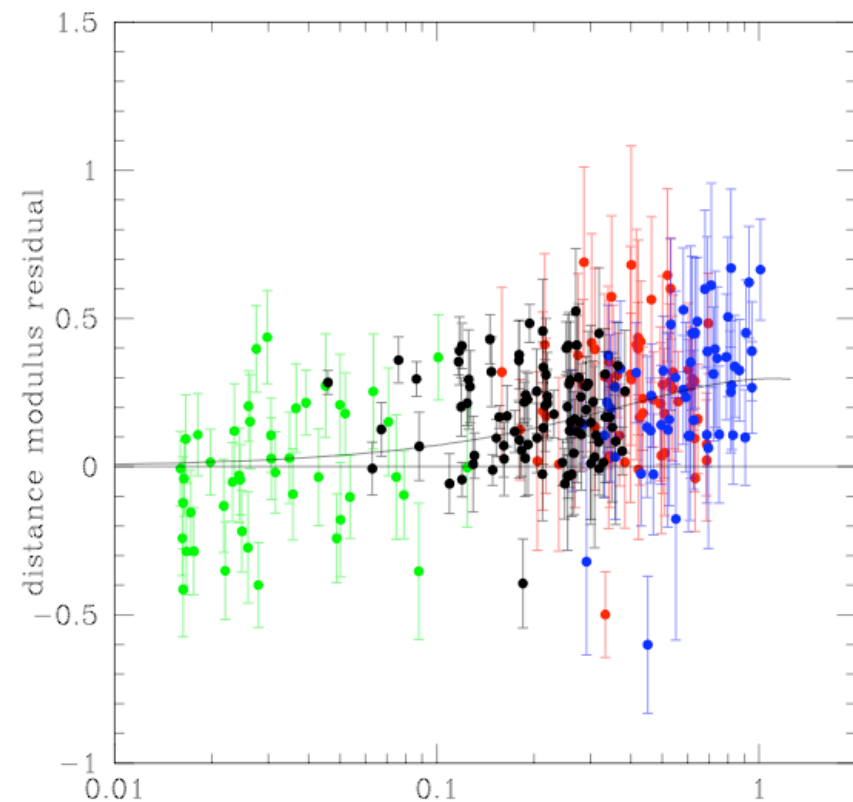
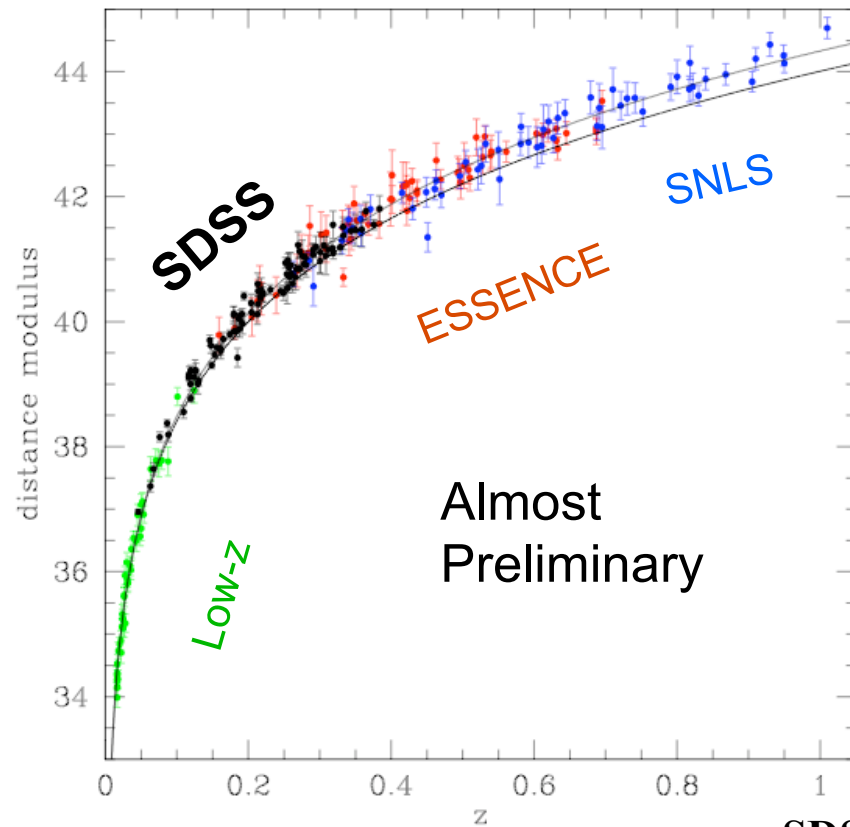
*Already 24
spectroscopically
confirmed SNe (as of
09/18/2007) since 3rd
season started in
Sep. 2007*



Frieman et al. (2007), submitted; see also Sako et al. (2007), submitted



Hubble Diagram



- **SDSS 2005 Data**
 - 130 SNe Ia
 - ~89 after cuts
 - Kessler, Miknaitis et al (2007) to appear



SDSS SN Publications



- **The Peculiar Type Ia Supernova 2005hk: Do Some Type Ia Supernovae Explode as Pure Deflagrations?** M. M. Phillips et al, PASP, 119, 360 (2007)
- **A Study of the Type Ia/IIIn Supernova 2005gj from X-ray to the Infrared: Paper I**, J. L. Prieto et al, astro-ph/0706.4088, submitted to AJ
- **The SDSS-II Supernova Survey: Technical Summary**, J. Frieman et al., submitted to AJ
- **The SDSS-II Supernova Survey: Search Algorithm and Follow-up Observations**, M. Sako et al., to be submitted to AJ
- **Light Curves from the SDSS-II Supernova Survey**, J. Holtzman et al., to be submitted to AJ
- **First Year Spectroscopy of the SDSS-II Supernova Survey**, C. Zheng et al., to be submitted to AJ
- **A Measurement of the Rate of type Ia Supernovae at Redshift 0.1 from the first season of the SDSS-II Supernova Survey**, B. Dilday et al., to be submitted to ApJ
- **The Rate of type Ia Supernovae vs. Host-Galaxy Properties from the first season of the SDSS-II Supernova Survey**, M. Smith et al., in preparation
- **Hubble Diagram and Cosmological Constraints from the first season of the SDSS-II Supernova Survey**, R. Kessler, G. Miknaitis et al., in preparation
- **Late-time Photometry and Spectroscopy of SN 2005hk**, S. Jha et al., in preparation



SDSS Community Science Impact

- **Data Release 6 made public end of June 2007**
- **Imaging area**
 - **8400 deg² Legacy**
 - **1600 deg² SEGUE**
- **Over 1,200,000 spectra, including 100,000 from SEGUE**
- **1581 refereed papers related to SDSS**
- **Over 50,000 citations of these papers**
- **CAS SQL database: over 8,000,000 queries in '04 and '05**
- **Over 60 Terabytes served over the internet**
- **Over half of all publications by users of the data NOT affiliated with SDSS**



SDSS-II is entering its last of three years of operations and is meeting its baseline imaging and spectroscopic goals.

- **Public release of DR6 was on schedule and SDSS data is being widely used by the astronomy community.**
- **SDSS results and papers are numerous, diverse, and exciting.**
- **Database Archive is an unmatched resource for the Astrophysics community world-wide.**
- **SDSS-II is exploring Dark Matter and Dark Energy with its SEGUE, Supernova, and Legacy programs.**